

SCIENCE FOR GLASS PRODUCTION

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A METHOD FOR PREPARING HOMOGENEOUS GLASS BATCH

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A method for producing a homogeneous glass batch is proposed involving the introduction of finely dispersed and hygroscopic materials in the form of microgranules with subsequent compaction of the batch. The glass batch prepared by this method has high homogeneity and chemical activity.

The strict requirements imposed on a glass batch, such as homogeneity of its chemical composition, constancy of the granulometric composition of the components, absence of stratification, mechanical impurities, dusting, and volatilization at all stages of transportation and melting, and power saving in transportation make the process of batch preparation a critical stage in the production of high-quality glass articles.

The process of batch preparation usually includes the following technological operations: milling, screening, drying of hygroscopic materials, proportioning and feeding particular components into a blender, moistening, and mixing. However, this method traditionally used on automatic production lines encounters certain difficulties in the case of alumina-bearing components. Alumina is introduced in industrial glass batches via pegmatite, feldspar, nepheline, kaolin, and feldspar concentrates.

Mechanical feeding devices are not used to deliver alumina in view of its fluidity and dusting, replacement of alumina with feldspar and pegmatite increases the amount of impurities and lowers the content of the principal component, whereas replacement of feldspar by kaolin results in the formation of clots which, entering the tank furnace, cause substantial fluctuations in glass melt homogeneity and the formation of the batch stone, i.e., mullite [1].

Below we describe the results of our study and propose a method for producing chemically homogeneous batch taking the container glass batch as example.

The alumina-bearing material in our research was kaolin from the Tuganskoe deposit (Tomsk Region). This is due, on the one hand, to the highly nonuniform distribution of feldspar materials on the Russian territory and, on the other hand, to the necessity of integrated utilization of natural ma-

terials and protecting the environment from pollution and to the increasing scarcity and cost of energy carriers.

A homogenized kaolin sample taken from the hydrated tails of the Tuganskoe deposit was dried at a temperatures of 110 – 115°C and crushed in a ball mill to full passage through a sieve with 0.05 mm holes. The prevailing mineral in kaolin is kaolinite and the impurities are quartz and hydromica. The chemical composition of kaolin is as follows (wt.%): 59.32 SiO₂, 25.50 Al₂O₃, 2.38 Fe₂O₃, 0.70 CaO, 0.50 MgO, 1.34 TiO₂, and 10.26 calcination loss.

Tuganskoe kaolin has a higher content of impurities, including SiO₂, CaO, and MgO, which are contained in most glasses and can be taken into account in batch preparation, and Fe₂O₃ and TiO₂, which are colorant impurities and restrict the application area of this kaolin.

To prepare a chemically homogeneous glass batch, we propose introducing kaolin in the form of granules of size less than 0.8 mm obtained from a mixture of kaolin and soda. In this way a part of the soda, namely its finely dispersed component in the form of granules, enters the batch at the stage of component mixing and the rest is introduced by the traditional method.

Granulation of the kaolin-soda mixture was implemented by extrusion. A special rotor-blade granulator was designed for this purpose, which consists of a cylindrical body that has a shaft in its center with blades contacting the bottom mesh. The lower part of the blades bent in the direction of rotation facilitates an efficient squeeze of the working mixture through the sieve holes and in the reverse stroke purifies the sieve surface from the material adhering.

The material was supplied using a feeder via an opening in the upper lateral part of the granulator. The feeder was a two-shaft blade blender containing a branch pipe for water supply in the middle part of its body. The water passes

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through a tube with holes located under the blender lid and evenly moistens the working mixture in mixing. The kaolin/soda ratio in the working mixture for producing granules was selected experimentally. Mixtures with kaolin/soda ratio of 50 : 50, 25 : 75, and 20 : 80% were granulated.

It was found that the maximum yield of granules (90–95%) and the minimum quantity of spilled material was registered with moisture content of 14% and a kaolin/soda ratio of 25 : 75%. The specified load on the granule layer of height 5 mm was equal to 12–14 Pa.

The obtained granules do not require preliminary drying, since they virtually do not cake in protracted (one year) storage in open air. The product granulated in this way has high chemical homogeneity (the deviation in Na_2CO_3 content is not more than $\pm 0.4\%$). However, the introduction of granules of spherical or nearly spherical shape, whose physico-mechanical characteristics differ from other batch components, may lead to stratification of the glass batch in storage and transportation and, consequently, disturb its chemical homogeneity. Therefore, when using this method of preparation of the batch components, the glass batch should be granulated.

Granulation was implemented by two methods: pelletizing on a plate granulator and continuous compacting on a roll press.

The batch subjected to granulation was an industrial batch for container glass constituting a mixture of sand, dolomite, soda ash, and granulated kaolin-soda concentrate, which allowed for 100% replacement of feldspar in the batch composition. This batch in the air-dry state was fed on the granulator plate and moistened with water using a sprayer. Water penetrating into a batch layer propagates under the effect of capillary forces and fills the pores between particles of different types and structures. As moistened particles of the batch components contact the surface of microgranules of the kaolin-soda concentrate, coagulation contacts are formed. The redistribution of the liquid in the contact zone due to the diffusion of moisture into the volume of the granules makes the liquid interlayers thinner and increases the strength of the granules. A further redistribution of moisture and an increase in its volume due to the dissolution of soda and mechanical loads on granules colliding against the batch layer and the plate edge leads to conditions favorable for the growth and stabilization of the granule structure. In general the granulation process proceeds steadily with 100% yield of granules of size 7–12 mm, moisture 22–24%, and strength 500–600 gf/granule.

The deviation in Na_2CO_3 content in the granulated batch is $\pm 0.5\%$.

However, to improve the technological properties of granules, it is necessary to include the operation of drying in the batch preparation schedule.

Comparative tests involved compaction on a roller press of glass batches constituting mixtures of powdered components with partial replacement of these components by the granulated kaolin-soda concentrate, and the yield of tablets (of thickness 4 mm) was 90–95%. However, the mechanical strength of tablets produced from the batch with the granulated concentrate on the average is 2–3% lower than in compaction of the traditional (powdered) batch. The slight loss in the strength of the tablets is presumably related to the destruction of granules in the compaction zone and the emergence of locally undermoistened microzones inside the tablet, since the liquid phase at the moment of compaction does not have time to redistribute itself inside the tablet volume, which decreases the number of coagulation contacts and, accordingly, the strength of the tablets. In storage, the strength of tablets increases due to the redistribution of the liquid phase and transformation of the coagulation contacts into crystalline ones. Glass batches produced in this way had high chemical homogeneity (deviation in Na_2CO_3 content amounted to $\pm 0.5\%$).

Experimental industrial melting of container glass based on the traditional batch and on the batch prepared according to the above technology was implemented at the Tomsk Electric Bulb Works. Melting was carried out in a pot furnace (pot capacity 1 liter) heated by natural gas and equipped with two standard burners at a heating rate of 100 K/min with a maximum melting temperature of 1480°C. The visual evaluation of samples taken in melting indicates that the batches containing the granulated concentrate were melted and partly clarified at a temperature of 1300°C and totally melted and clarified at 1400°C, whereas samples of traditional batches were not completely clarified.

The TCLE and thermal resistance of standard samples of the glass obtained satisfy the requirements imposed on container glass.

Thus, introducing finely dispersed clotting and hygroscopic components into glass batches in the form of microgranules with their subsequent compaction makes it possible to obtain homogeneous batches that have an increased chemical activity.

REFERENCES

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